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Perception of the Norwegian Word Tones in Patients with Alzheimer's Disease (AD)

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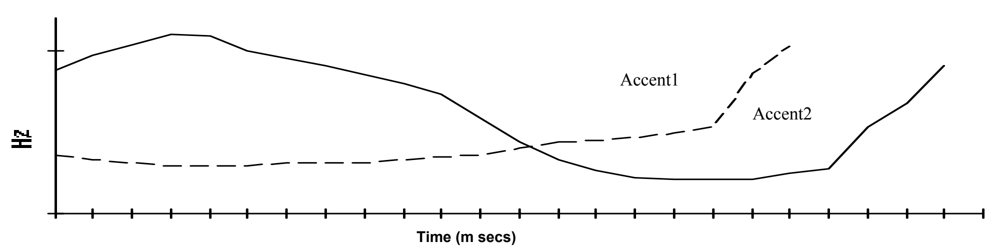
The present investigation is a pilot study exploring the ability of AD patients to distinguish auditorily between the two Norwegian word tones, compared to elderly controls and previous investigations of patients with aphasia. Aphasic patients have been shown to have reduced perception of tonal contrasts as a result of a phonological breakdown. The cognitively weakest AD patients show reduced discriminative ability compared to the controls. Since AD is a heterogeneous neurodegenerative disorder and aphasia a symptom of a more distinct cerebral damage, it cannot be assumed that impaired tonal discrimination is the result of the same underlying linguistic deficiency in the two groups. The study indicates that the AD patients' discriminative problem may be associated with reduced semantic abilities, possibly combined with a phonological breakdown. A test of this type might be used, in conjunction with other tests, to help distinguish between elderly patients with and without AD or aphasia.

Introduction

The present investigation explores the ability of elderly patients with dementia of the Alzheimer's type (AD) to distinguish perceptually between the two Norwegian word tones. In Norwegian every accented syllable will carry the pitch pattern of one of two possible tones, referred to as Accent 1 and Accent 2. The auditory correlate of the accents is variation in pitch contour. The acoustic correlate is variation in fundamental frequency. The choice between the two accents is normally lexically determined. That is, the accent must be listed in the lexicon together with the word's segmental phonological structure. There are a number of minimal pairs differing only in accent.

Figure 1
F0 patterns of the two East Norwegian pitch accents



Moen & Sundet (1996), in an investigation of two groups of neurologically impaired patients, a right hemisphere damaged group (RHD), with no aphasic symptoms, and a left hemisphere damaged group (LHD), with aphasia, found that the ability to distinguish auditorily between the two pitch accents was not impaired in the RHD group, in contradistinction to the LHD group where the performance varied from 100 to 50% correct responses. Similar results have been found with aphasic patients of other tone languages (for a review see Baum & Pell, 1999). The unimpaired performance of the RHD group is not unexpected in view of the fact that dichotic listening studies with normal speakers of tone languages have demonstrated a left hemisphere bias for the ability to perceive tonal contrasts (Van Lancker & Fromkin, 1973; Moen, 1993).

AD patients suffer from a progressive neurodegenerative disorder affecting both cerebral hemispheres. It is therefore possible that their perception of tonal distinctions might differ from that of patients with unilateral cerebral damage and from normal controls. A possible difference in the ability to distinguish between the word tones in the normal elderly population, in patients with aphasia, and in AD patients would be of interest from a diagnostic point of view. The incidence both of aphasia and of AD is higher in the elderly than in the younger population. An elderly patient may suffer both from aphasia and from AD, and a relatively simple language test distinguishing between aphasia due to unilateral cerebral damage and AD, would be a useful clinical tool.

Experiment

The test used in the experiment was the same as the one used in the investigation of Norwegian RHD and LHD patients referred to above.

Subjects

The experiment involved two subject groups, a group of 10 AD patients and a group of 10 normal age matched controls. The patients were over sixty-five years of age, had been diagnosed at least three years previously, and suffered from a relatively mild and slowly progressing AD. They had been assessed clinically at The Norwegian Centre for Dementia Research, Ullevaal University Hospital, Oslo. Single Photon Emission Computed Tomography (SPECT) had been performed on all patients. They had all been treated with reversible cholinesterase inhibitors. The sample characteristics of the AD patients are shown in table 1.

Stimuli

The stimuli were a set of drawings illustrating the members of minimal pairs of words differing only with regard to accent type. The illustrations of each pair were placed above each other vertically. This was done in order to avoid any interference of left or right visual preference – or neglect – in the subjects. Pictures, rather than orthographic representations, were used because many of the members of minimal pairs have identical, or near identical, spellings. The test words were chosen on the basis of their "picturability."

Table 1
Sample characteristics of the AD patients

Patient	Sex	Age	MMSE	OLT	Clock	TMT-A	TMT-B	AC-test
1	F	75	22	17	—	55	95	5
2	F	75	19	13	0	60	cannot	1
3	F	82	23	17	4	46	cannot	4
4	F	79	25	25	4	45	100	0
5	M	73	28	26	7	47	119	0
6	M	72	24	18	5	47	117	7
7	F	76	27	24	4	39	—	1
8	F	76	20	9	5	60	cannot	4
9	F	68	19	15	0	—	—	5
10	F	75	20	10	6	83	cannot	1

Educational level: patients 4 and 10: university education, the other patients: between 7-10 years of education

MMSE=Mini Mental state Examination (max score 30, best)
OLT=Object Learning Test (max score 70, best)
Clock drawing test (max score 7, best)
TMT-A=Trail Making Test version A (short time is best)
TMT-B=Trail Making Test version B (short time is best)
AC-test=Accent discrimination test (score above 2=impaired performance)

Listening procedure

The subjects were presented with a pair of drawings. The test words were read by the examiner, and the subjects were asked to point to the picture corresponding to the stimulus word. The test involved eight minimal pairs. The pairs were presented four times in such a way that each member was the target twice. In the analysis of the results the first set of presentations for each subject was discarded. The conclusions are thus based on 24 responses from each subject.

Results and discussion

Two of the ten control subjects made one mistake, one control subject made two mistakes, and seven control subjects made no mistakes. We therefore consider more than two mistakes to indicate impaired performance. The AD patients varied in the accuracy of their responses. Two of the patients identified all the target words correctly. Three of the patients made one mistake. Thus half of the AD subjects' responses matched that of the normal controls. Of the remaining five AD subjects two made four mistakes, patients 3 and 8, two five mistakes, patients 1 and 9, and patient 6 made seven mistakes.

Low cognitive test scores correspond to impaired performance on our test, with two notable exceptions. Patient number 10 made only one mistake, although she has low cognitive test scores. The reason for her unimpaired performance on the present test may be attributed to her educational level. She is one of the two patients with a university education. Higher education is known to have a positive effect on performance in formal test situations. The other exception is patient number 6, the patient who made most mistakes on the present test. His scores on the cognitive tests are higher than those of the other AD patients with impaired performance. A possible contributing factor to his impaired performance might be linked to the distribution of his cerebral lesions. If the damage includes areas implicated in semantic processing, he may have problems distinguishing the meanings of the word pairs presented to him, in addition to a possible accent discrimination problem.

In order to understand a spoken word, the listener has to convert acoustic input into meaning. This involves at least two distinct processes, phonetic and phonemic decoding and lexical activation. If the ability to distinguish between two different phonological strings is impaired, this may lead to the activation of a wrong word in the mental lexicon. This is presumably the reason why some patients with aphasia fail to distinguish between minimal pairs of words differing only in accent type. If the distinction between different lexical items is reduced due to a breakdown in semantic memory, the ability to differentiate between pairs of words will also be reduced, and a wrong lexical item may be activated. Lexical semantic impairments is a well documented characteristic of many AD patients (Bayles & Kaszniak, 1987), and the behaviour of the AD patients during our experiment also indicated a semantic problem. Whereas the patients with aphasia pointed relatively unhesitatingly to one of the two pictures when the stimulus word had been presented, the AD patients talked about the pictures, commented on similarities and differences in the drawings before they made their choice. In some cases they repeated the stimulus word, looked at the pictures and said, "There is no difference." It is, however, not possible on the basis of this test alone to decide whether the AD patients' problem is purely semantic or a combination of blurred semantic distinctions and reduced phonological perception.

Conclusions

The ability to distinguish between the two Norwegian word tones may be reduced as a result of AD, particularly in patients with low test scores on clinical tests of cognitive abilities. Previous tests of patients with aphasia have also shown reduced ability to distinguish auditorily between the two word tones, presumably as a result of a phonological impairment. The AD patients' behaviour during the present test indicated, in addition to a possible phonological impairment, a breakdown in semantic memory. Reduced ability to distinguish between the two Norwegian word tones in an elderly patient may be indicative both of aphasia and of AD. Additional tests will be necessary in order to establish the nature of the cerebral disorder.

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